A Noise Analysis Approach for Measuring Effective Delayed Neutron Parameters in the IPEN/MB-01 Reactor

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The purpose of this work is to introduce a new in-pile experiment for the determination of the relative abundances (Betas) and decay constants (Lambdas) of delayed neutrons through the noise analysis technique. The experimental procedure consists of obtaining the Cross Power Spectral Density (CPSD) and the Auto Power Spectral Density (APSD) from the signals of two compensated ionization chambers in the frequency range from 0.005 to 50.0 Hz approximately. Assuming the point kinetic model in the detectors position we can write the theoretical expression for the CPSD and the APSD's and the experimental data can be fitted by means of a least-square procedure. The fitting parameters are the Beta(i) or Lambda(i), i=1..6, for a six group model.

With these experimental spectral densities the least-squares procedure was able to fit 5 out of 6 of the relative abundances. The relative abundance of the first group must be fixed in order to achieve convergence of the fitting. For the decay constants occurs the same i.e., the first decay constant (the group of longest half-life) must be fixed. The fixed parameters are those of the three nuclear data libraries, namely ENDF/B-IV, ENDF/B-VI.8 (LANL revised) and JENDL 3.3. To make possible the comparison between theory and experiment the library decay constants must be fixed for the fitting of Betas and vice-versa.

The parameters were obtained with great accuracy (small errors due to the fitting procedure) but the comparison with calculated results from the above libraries presents some deviation, being the higher one on the order of 20% for the lowest half-life. However, even the comparison between libraries also presents higher discrepancies. The experimental technique also allows the determination of the effective beta without the need of the Diven factor and the power normalization.

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